

#### LIBBY-SPECIFIC LUNG CANCER KL VALUES

Study	Location	Asbestos Type	Reference Population	Exposure Metric	TSFE (yrs)	KL(PCM f/cc-yrs) <sup>-1</sup> (x 100)		
						$\alpha = 1$	$\alpha = \text{fitted}$	Exact ( $\alpha=1$ )
Amandus et al. 1987	Libby	LA	US Males	CE	All	0.42	0.33	
			US Males		> 20	0.52	0.65	
			Montana males		> 20	0.66	0.64	
McDonald et al. 1986	Libby	LA	Montana Males	CE	All	1.05	0.39	
					> 20	1.27	0.70	
McDonald et al. 2004	Libby	LA	Montana Males	CE10	All	0.71	0.23	0.36

#### AMPHIBOLE-ONLY LUNG CANCER KL VALUES

Study	Location	Asbestos Type	Reference Population	Exposure Metric	TSFE (yrs)	KL(PCM f/cc-yrs) <sup>-1</sup> (x 100)	
						$\alpha = 1$	$\alpha = \text{fitted}$
Seidman et al. 1986	New Jersey	Amosite	New Jersey males	CE	5 to 39	5.97	1.01
de Klerk et al. 1989	Wittenoom	Crocidolite	Matched controls	CE	All	0.30	0.44
Levin et al. 1998 (a)	Texas	Amosite	US Males	CE	> 10	1.30	0.17

(a) Data are binned by duration rather than CE or CE10 so results require assumptions not needed for other studies (i.e., uncertainty is higher).



0.374351

Amandus and Wheeler 1987

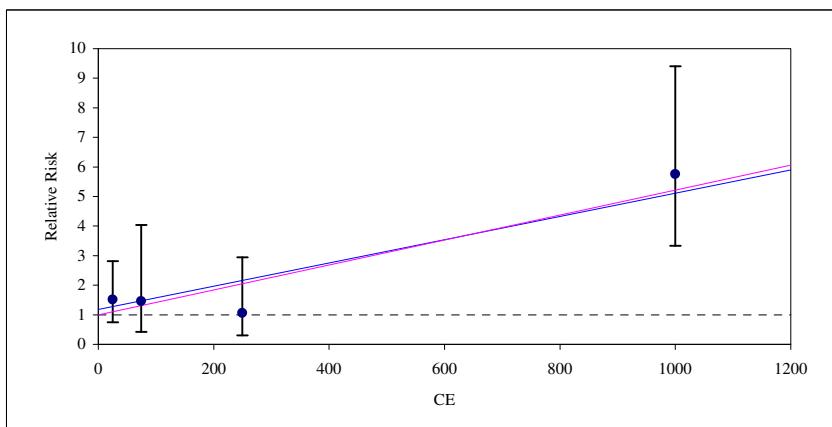
Lung Cancer Mortality among Vermiculite Mine and Mill Workers  
Mines and Mills Near Libby, Montana

CE (PCME f/cc-yr)		SMR (a)	Observed Deaths (a)	Expected Deaths (a)	Relative Risk		
Range (a)	Mean (a)				Pt. Est.	5% LB	95% UB
<50	25	151.2	6	3.97	1.51	0.74	2.82
50-99	74.5	145.8	2	1.37	1.46	0.42	4.04
100-399	249.5	106.2	2	1.88	1.06	0.30	2.94
>399	1000	575.5	10	1.74	5.76	3.34	9.40

a) Data reported in Table II (Amandus and Wheeler 1987)

Value for upper bin chosen to approximate linear regression results reported by authors

MLE Fitting			
alpha	1.00	alpha	1.17
K <sub>l</sub> x100	0.4217	K <sub>l</sub> x100	0.3347
ΣLL	-7.3911	ΣLL	-7.3174
AIC	16.782	AIC	18.635
Alpha = 1 (fixed)		Alpha = fitted	
Predicted	LL	Predicted	LL
4.4	-2.0945	5.1	-1.9125
1.8	-1.3173	2.0	-1.3069
3.9	-1.8542	4.1	-1.9509
9.1	-2.1251	8.9	-2.1472



Amandus and Wheeler 1987

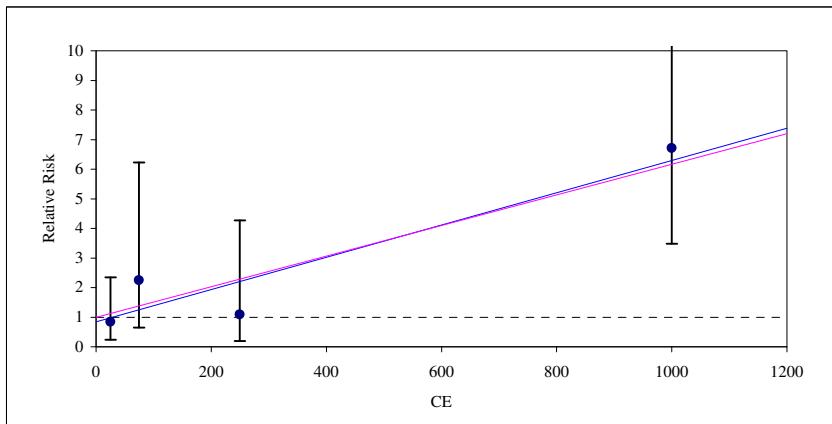
Lung Cancer Mortality among Vermiculite Mine and Mill Workers  
Mines and Mills Near Libby, Montana

Reference = US Males

CE (PCME f/cc-yr)		SMR (a)	Observed Deaths (a)	Expected Deaths (a)	Relative Risk		
Range (a)	Mean (a)				Pt. Est.	5% LB	95% UB
<50	25	84.7	2	2.36	0.85	0.24	2.34
50-99	74.5	225.1	2	0.89	2.25	0.64	6.23
100-399	249.5	109.3	1	0.91	1.09	0.19	4.27
>399	1000	671.3	7	1.04	6.71	3.48	11.99

a) Data reported in Table III (Amandus and Wheeler 1987)

Value for upper bin chosen to approximate linear regression results reported by authors



MLE Fitting			
alpha	1.00	alpha	0.84
K <sub>L</sub> x100	0.5165	K <sub>L</sub> x100	0.6453
ΣLL	-6.1903	ΣLL	-6.1562
AIC	14.381	AIC	
Alpha = 1 (fixed)		Alpha = fitted	
Predicted	LL	Predicted	LL
2.7	-1.3980	2.3	-1.3293
1.2	-1.5089	1.1	-1.5941
2.1	-1.3549	2.0	-1.3146
6.4	-1.9284	6.6	-1.9183

Simple linear regression

alpha	0.803
slope	0.0057
KL	0.0071
alpha	1.0000
slope	0.0055
KL	0.0055

Amandus and Wheeler 1987

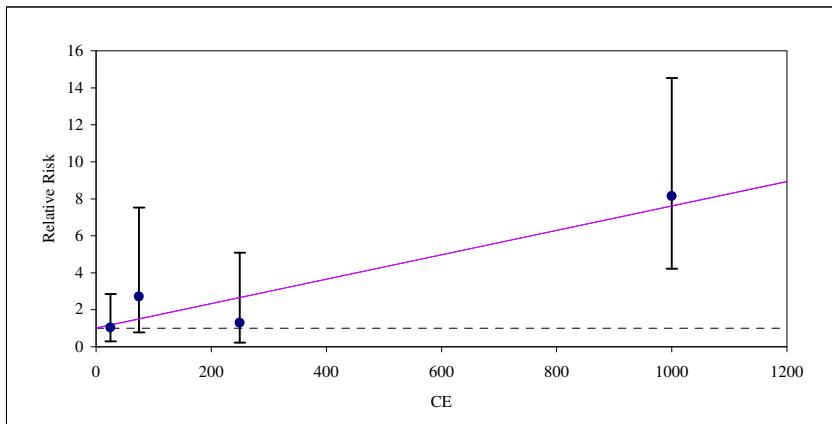
Lung Cancer Mortality among Vermiculite Mine and Mill Workers  
Mines and Mills Near Libby, Montana

Reference = Montana males

CE (PCME f/cc-yr)		SMR (a)	Observed Deaths (a)	Expected Deaths (a)	Relative Risk		
Range (a)	Mean (a)				Pt. Est.	5% LB	95% UB
<50	25	103	2	1.94	1.03	0.29	2.85
50-99	74.5	272	2	0.74	2.72	0.78	7.53
100-399	249.5	130	1	0.77	1.30	0.23	5.08
>399	1000	814	7	0.86	8.14	4.22	14.53

a) Data reported in Table II (Amandus and Wheeler 1987)

Value for upper bin chosen to approximate linear regression results reported by authors



MLE Fitting			
alpha	1.00	alpha	1.02
K <sub>L</sub> x100	0.6622	K <sub>L</sub> x100	0.6445
ΣLL	-6.1726	ΣLL	-6.1722
AIC	14.345	AIC	
Alpha = 1 (fixed)		Alpha = fitted	
Predicted	LL	Predicted	LL
2.3	-1.3228	2.3	-1.3276
1.1	-1.6041	1.1	-1.5933
2.0	-1.3271	2.0	-1.3314
6.6	-1.9186	6.5	-1.9198

Simple linear regression

alpha 0.9642  
slope 0.0069  
KL 0.0072

alpha 1.0000  
slope 0.0097  
KL 0.0097

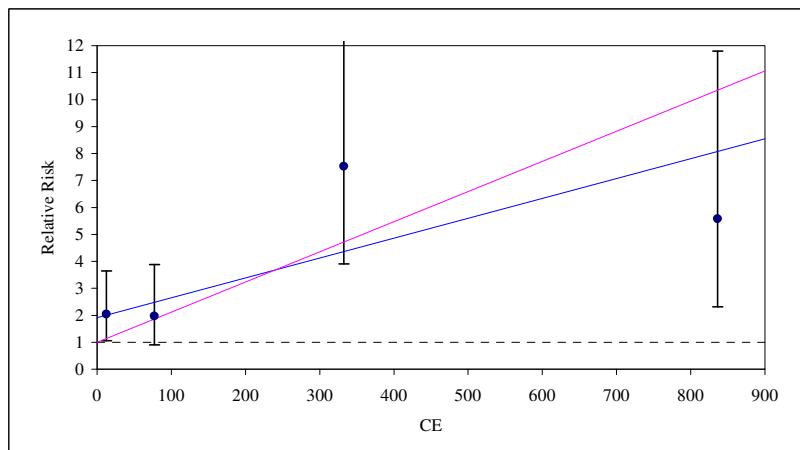
**McDonald et al. 1986**  
**Respiratory Cancer Mortality among Vermiculite Mine and Mill Workers**  
**Mines and Mills Near Libby, Montana**

CE (PCME f/cc-yr)		Observed Deaths (a)	Expected Deaths (b)	Relative Risk		
Range (a)	Mean (a)			Pt. Est. (a)	5% LB	95% UB
<25	12.5	7	3.43	2.04	1.06	3.64
25-199	77.3	5	2.54	1.97	0.90	3.88
200-499	332.4	7	0.93	7.53	3.91	13.44
≥500	836.1	4	0.72	5.58	2.32	11.80

a) Data reported in Table 4 (McDonald et al. 1986)  
b) Calculated value as expected deaths = observed deaths/RR

MLE Fitting			
alpha	1.00	alpha	1.91
K <sub>L</sub> x100	1.0544	K <sub>L</sub> x100	0.3863
ΣLL	-9.7659	ΣLL	-8.5129
AIC	21.532	AIC	21.026
Alpha = 1 (fixed)		Alpha = fitted	
Predicted	LL	Predicted	LL
3.9	-2.9114	6.9	-1.9051
4.6	-1.7566	6.3	-1.8830
4.2	-2.6877	4.1	-2.7817
7.0	-2.4102	5.8	-1.9431

LINES	
Alpha = fitted	
0	1.91
900	8.55
Alpha = 1	
0	1.00
900	11.06
Reference	
0	1
900	1



**McDonald et al. 1986**  
**Respiratory Cancer Mortality among Vermiculite Mine and Mill Workers**  
**Mines and Mills Near Libby, Montana**

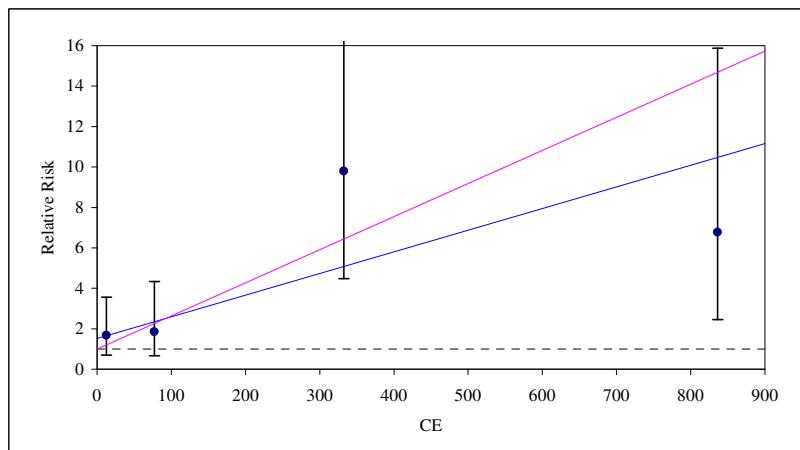
CE (PCME f/cc-yr)		Observed Deaths (a)	Expected Deaths (b)	Relative Risk		
Range (a)	Mean (a)			Pt. Est. (a)	5% LB	95% UB
<25	12.5	4	2.38	1.68	0.70	3.55
25-199	77.3	3	1.62	1.85	0.67	4.34
200-499	332.4	5	0.51	9.80	4.48	19.28
≥500	836.1	3	0.44	6.77	2.45	15.87

a) Data reported in Table 4 (McDonald et al. 1986)  
b) Calculated value as expected deaths = observed deaths/RR

MLE Fitting			
alpha	1.00	alpha	1.53
K <sub>L</sub> x100	1.27	K <sub>L</sub> x100	0.7014
ΣLL	-7.9573	ΣLL	-7.6673
AIC	17.915	AIC	19.335
Alpha = 1 (fixed)		Alpha = fitted	
Predicted	LL	Predicted	LL
2.8	-1.8779	4.0	-1.6332
3.2	-1.5030	3.8	-1.5900
2.7	-2.5554	2.6	-2.6163
5.1	-2.0209	4.6	-1.8279

slope	LINES
1.07	Alpha = fitted
	0 1.53
	900 11.16
Alpha = 1	
	0 1.00
	900 15.74
Reference	
	0 1
	900 1

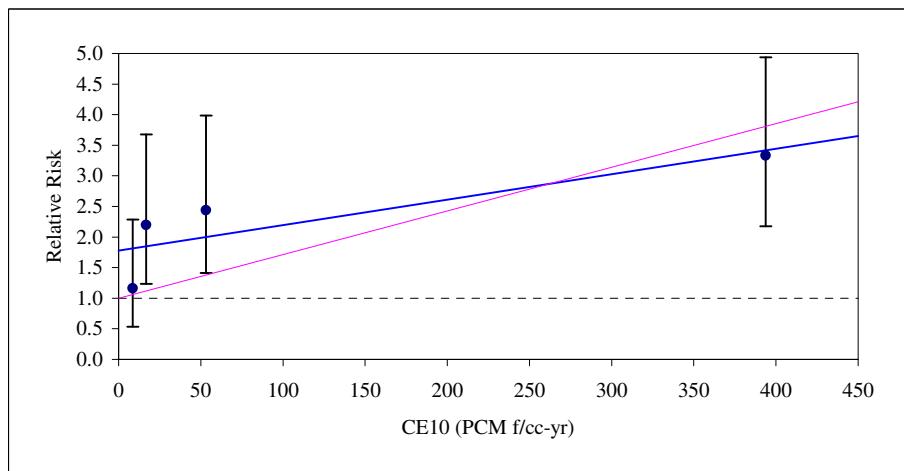


**McDonald et al. 2004**  
**Lung Cancer Mortality among Vermiculite Mine and Mill Workers**  
**Mines and Mills Near Libby, Montana**

CE (PCME f/cc-yr)		Observed Deaths (a)	Expected Deaths (a)	Relative Risk		
Range (a)	Mean (a)			Pt. Est.	5% LB	95% UB
0-11.7	8.6	5	4.3	1.16	0.53	2.29
11.7-25.2	16.7	9	4.1	2.20	1.23	3.68
25.2-113.8	53.2	10	4.1	2.44	1.41	3.98
113.8+	393.8	16	4.8	3.33	2.17	4.94

a) Data reported in Table 3 (McDonald et al. 2004).

MLE Fitting			
alpha	1.00	alpha	1.78
K <sub>L</sub> x100	0.7138	K <sub>L</sub> x100	0.2340
ΣLL	-11.3316	ΣLL	-9.0488
AIC	24.663	AIC	22.098
Alpha = 1 (fixed)		Alpha = fitted	
Predicted	LL	Predicted	LL
4.6	-1.7605	7.8	-2.3188
4.6	-3.6781	7.6	-2.1521
5.7	-3.4326	8.2	-2.2623
18.3	-2.4604	16.4	-2.3156

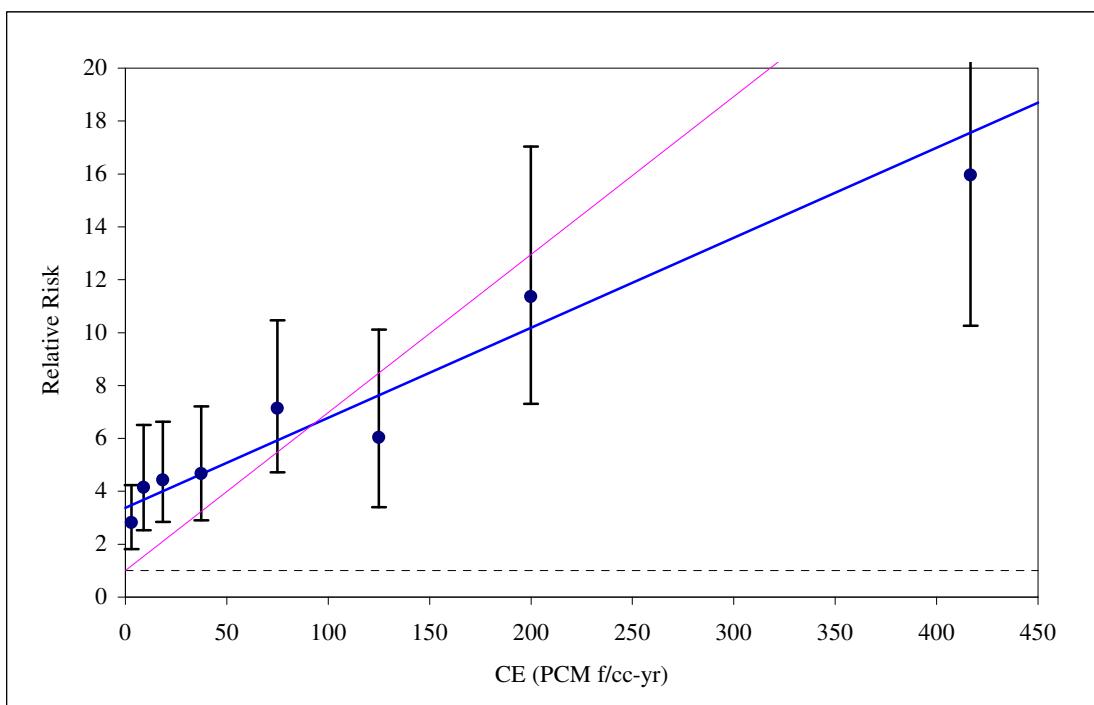


**Lung Cancer Mortality among Amosite Asbestos Factory Workers  
Patterson, New Jersey Insulation Manufacturing Factory**

CE (PCM f/cc-yr)		Observed Deaths (a)	Expected Deaths (a)	Relative Risk		
Range (a)	Mean (b)			Pt. Est.	5% LB	95% UB
<6	3	15	5.3	2.8	1.8	4.2
6-11.9	9	12	2.9	4.2	2.5	6.5
12-24.9	18.5	15	3.4	4.4	2.8	6.6
25-49.9	37.5	13	2.8	4.7	2.9	7.2
50-99.9	75	17	2.4	7.1	4.7	10.5
100-149.9	125	9	1.5	6.0	3.4	10.1
150-249.9	200	15	1.3	11.4	7.3	17.0
250+	416.7	15	0.9	16.0	10.3	23.9

a) Data reported in Table XVI (Seidman et al. 1986).

b) Calculated as the midpoint of the reported range of CE, except for the highest exposure group which has an unbounded range. The point estimate is assigned a value =  $5/3 \times$ lower bound.



**de Klerk et al. 1989**  
**Lung Cancer Mortality in Crocidolite Miners**  
**Wittenoom, Crocidolite Miners**

Conc. (f/cc) (a)		Cum Exp (b) (f/cc-yrs)	Number of Cases		Odds Ratio (d)		
Range	PE		Observed (a)	Expected (c)	Pt. Est. (a)	5% LB	95% UB
0-9.9	5.0	9.4	20.0	20.0	1.0	0.68	1.42
10-19.9	15.0	28.4	20.0	22.2	0.9	0.61	1.28
20-49.9	35.0	66.4	20.0	15.4	1.3	0.89	1.85
>= 50	83.3	158.3	19.0	12.7	1.5	1.01	2.15

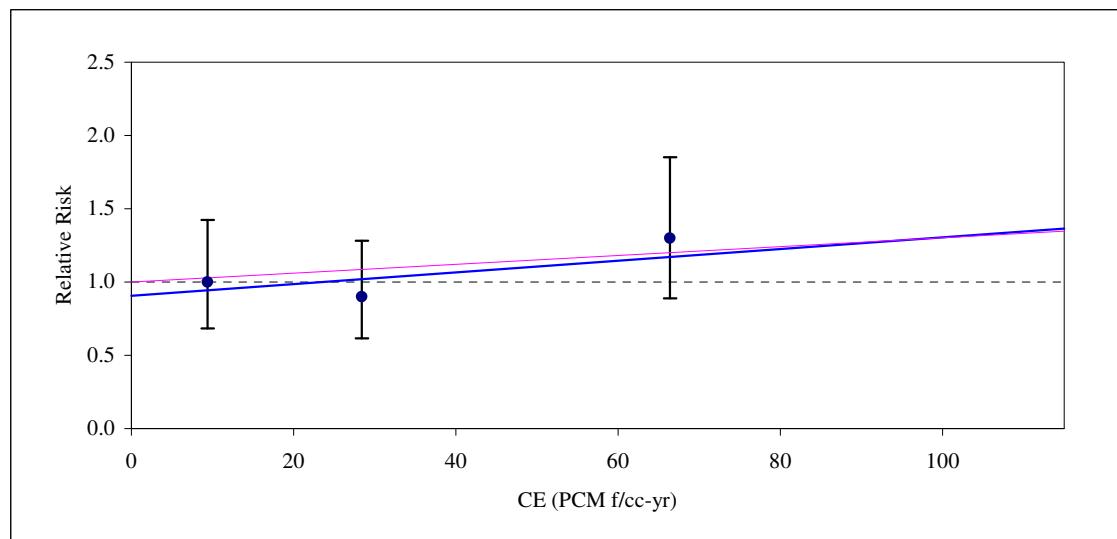
a) Data from Table 1 (de Klerk et al. 1989)

b) Point estimate of concentration multiplied by average exposure duration of 1.9 years.

c) Calculated from odds ratio (Expected = observed / odds ratio)

d) Odds ratio is taken to be a reasonable approximation of RR.

MLE Fitting	
alpha	0.905
K <sub>LX100</sub>	0.442
$\Sigma LL$	-9.9648
AIC	23.930
Alpha = fitted	
Predicted	LL
18.9	-2.4550
22.6	-2.5813
18.0	-2.5267
19.5	-2.4018



C	D	
5	1.9	
15		
37.5		
70		
0-9.9	4.95	
10-19.9	14.95	
20-49.9	34.95	
>=50	83.3	

**Levin et al. 1998**  
**Respiratory Cancer Mortality among Amosite Asbestos Factory Workers**  
**Tyler, Texas Insulation Manufacturing Factory**

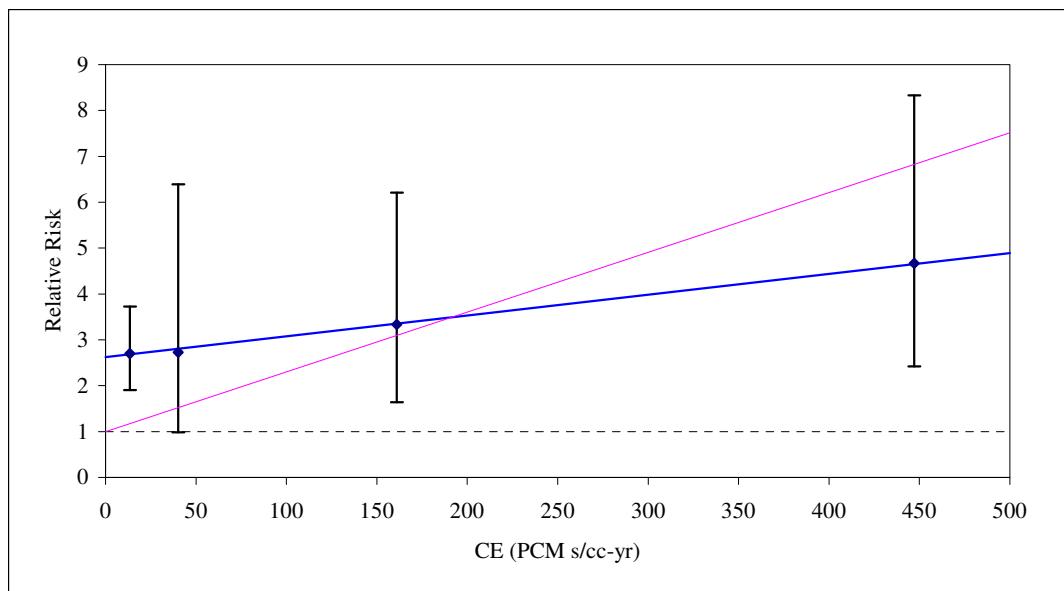
Duration (yrs)	CE (PCM s/cc-yr)		Observed Deaths (a)	Expected Deaths (a)	Relative Risk		
	Range (a)	Range (b)			Pt. Est.	5% LB	95% UB
< 0.5	0-26.8	13.41	24	8.9	2.70	1.9	3.7
0.5-1	26.8-53.65	40.24	3	1.1	2.73	1.0	6.4
1-5	53.65-268.25	160.95	6	1.8	3.33	1.6	6.2
> 5	>268.25	447.08	7	1.5	4.67	2.4	8.3

a) Data reported in Table 2 (Levin et al. 1998).

b) Concentration range reported by authors as 15.9 to 91.4 f/ml; average value of range equal to 53.65; CE10 calculated as the average concentration\*duration

c) Mean calculated as the average of the CE10 range, except for the group with the longest duration which is calculated as 5/3\*lower bound.

MLE Fitting			
alpha	1.00	alpha	2.62
K <sub>Lx100</sub>	1.3021	K <sub>Lx100</sub>	0.1725
ΣLL	-15.1522	ΣLL	-7.7415
AIC	32.304	AIC	19.483
Alpha = 1 (fixed)		Alpha = fitted	
Predicted	LL	Predicted	LL
10.5	-8.9106	23.9	-2.5116
1.7	-1.9183	3.1	-1.4972
5.6	-1.8447	6.0	-1.8288
10.2	-2.4786	7.0	-1.9038



Amandus and Wheeler 1987

Lung Cancer Mortality among Vermiculite Mine and Mill Workers  
Mines and Mills Near Libby, Montana

Group (i)	x(i)		Observed Deaths (a)	Expected Deaths (a)	Relative Risk		
					Pt. Est.	5% LB	95% UB
1	5		21	31.40	0.669	0.46	0.94
2	15		5	5.98	0.836	0.38	1.65
3	30		10	6.41	1.560	0.90	2.55
4	60		6	3.75	1.600	0.79	2.98
5	120		11	2.64	4.167	2.48	6.66

MLE Fitting			
alpha	1.00	alpha	0.52888
K <sub>L</sub> x100	1.6530	K <sub>L</sub> x100	5.10111
ΣLL	-14.2724	ΣLL	-10.7038
AIC	30.545	AIC	25.408
Alpha = 1 (fixed)		Alpha = fitted	
Predicted	LL	Predicted	LL
34.0	-5.3247	20.8	-2.4458
7.5	-2.2006	5.6	-1.7718
9.6	-2.0873	8.6	-2.1904
7.5	-1.9837	8.1	-2.1161
7.9	-2.6760	9.9	-2.1797

